



# The Nexus for Exoplanet System Science

## Research Coordination Network

### A Cross-division Initiative

<https://nexss.info>

Dr. Mary Voytek  
Senior Scientist for Astrobiology  
SMD, NASA HQ  
Heliophysics Subcommittee Meeting 8/8/16

A decorative graphic in the top-left corner featuring a cluster of celestial bodies including Saturn, Jupiter, the Moon, and Mars, with a bright starburst effect behind them.

# What is a Coordination Network?

A virtual structure to support groups of investigators to communicate and coordinate their research, training and educational activities across disciplinary, organizational, divisional, and geographic boundaries.



# Objectives

To further our joint strategic objective to explore exoplanets as potential habitable and inhabited worlds outside our solar system.

- Exoplanet research cuts across divisions in SMD including Planetary Science (PSD), Heliophysics (HPD), Earth Science (ESD) and Astrophysics (APD)

To leverage existing Programs in SMD to advance the field of Exoplanet Research, specifically research in comparative planetology, biosignature and habitat detection, and planet characterization.

Establish a mechanism to break down the barriers between, divisions, disciplines and stove piped research activities.



# What Research Coordination Networks have accomplished?

Provided opportunities to share information and ideas, foster new collaborations, including international partnerships, and address interdisciplinary topics.

Provided innovative ideas for implementing novel networking strategies, collaborative technologies.

Supported the development of community standards for data and meta-data.

Supported the means by which investigators can

- coordinate ongoing or planned research activities,
- and in other ways advance science and education through communication and sharing of ideas.





## Example Activities

Host a workshop (not mini symposium) to define the Habitable zone to include factors optimal orbit, size, distance from star, star type, radiation, magnetospheres, etc.

- Process is just as important as product

Develop an understanding of what future observations are needed to determine if exoplanets are habitable and inhabited



## Measure of Success

Investigators carry out and propose interdisciplinary research through new collaborations

Produces a plan for utilization of current space telescopes

Spawns ideas for new and exciting missions

Identifies new targeted technologies needed not yet reported elsewhere

Influences Decadals for both PSD and APD

Enhances International engagement

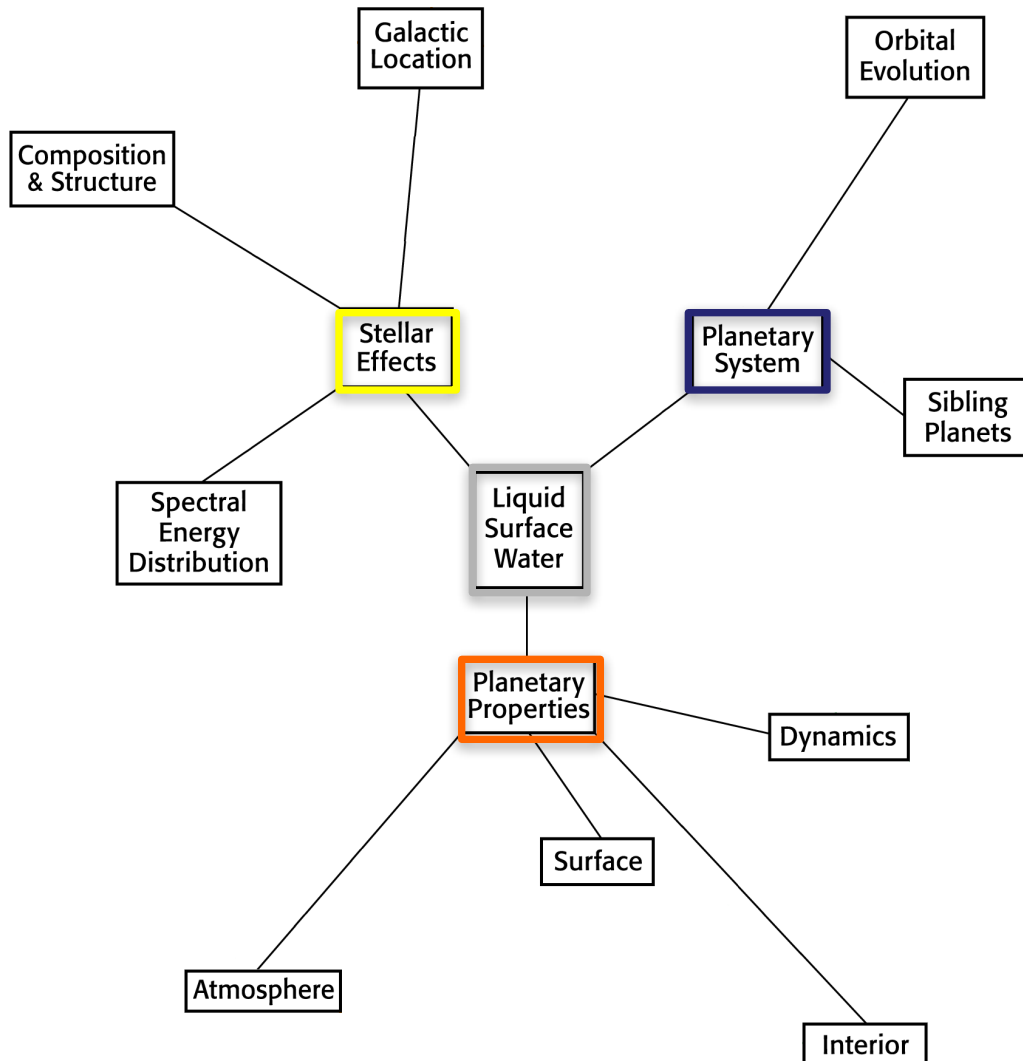
A decorative header featuring a collage of celestial bodies including Saturn, Jupiter, Mars, and the Moon, along with a bright star, set against a dark blue, starry background.

# Our Fundamental Requirement for Habitability

---



# Factors Affecting Habitability

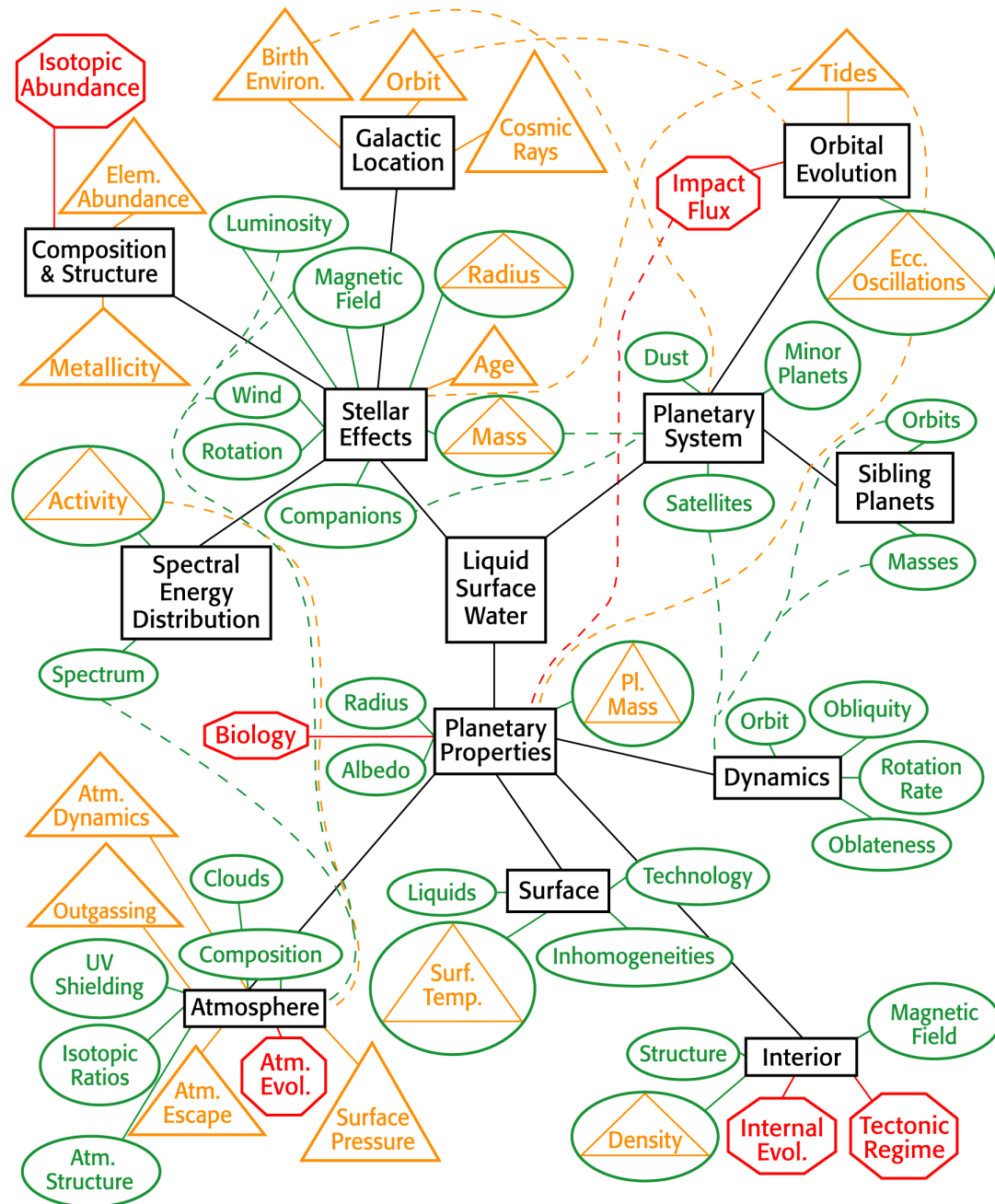


Habitability is an outcome of the interactions between a planet, its star, and its planetary system.

These interactions modify the planet's environment and evolution and can increase or decrease the probability that life's requirements will be met.



# Planets are Hard!



Habitability Assessment is a multiparameter, interdisciplinary process.

As a community, we want to understand the interplay of these many influences on habitability, and how they evolve with time.

The ultimate goal is the determination of a planet's "Habitability Factor", which will allow ranking of targets for follow-up.

# Implementation

## Astrophysics

Exoplanet Detection  
Star Characterization  
Existing Mission Data  
Analysis  
JWST

## PSD Astrobiology

Comparative Planetology  
Planetary atmospheres  
Exoplanet Detection  
Biosignatures  
Habitability

Earth  
Sciences

## PSD Exoplanet Research Program (XRP)

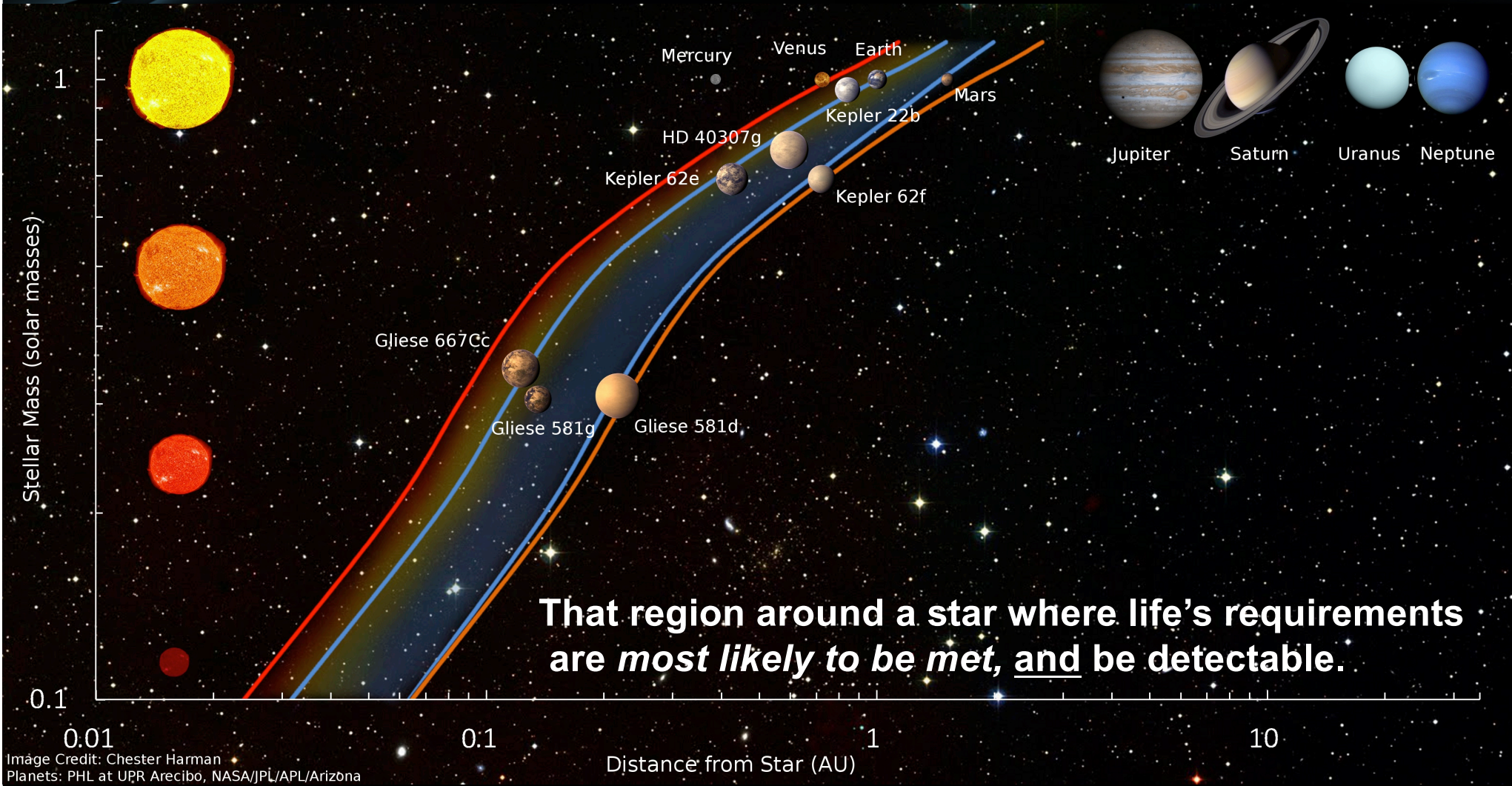
Exoplanet characterization  
Protoplanetary Disks  
Planet Formation  
Comparative Planetology

## Heliophysics

Detection of planetary  
magnetospheres  
Stellar winds  
Radiative Habitability



# The Radiative Habitable Zone



Kopparapu et al., (2013)

<http://depts.washington.edu/naivpl/content/hz-calculator>



# The NExSS Teams

D. Fischer  
E. Ford  
J. Wright  
D. Deming  
A. Jensen  
J. Graham

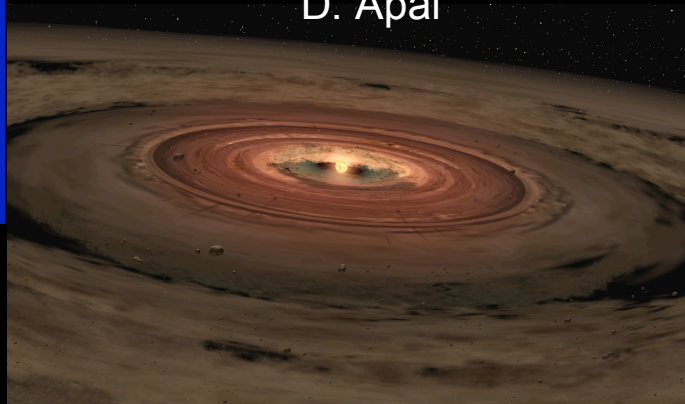
HQ reps:

Mary Voytek (PSD)  
Martin Still (APD)  
Jeff Newmark (HPD)  
Shawn Domagal-Goldman

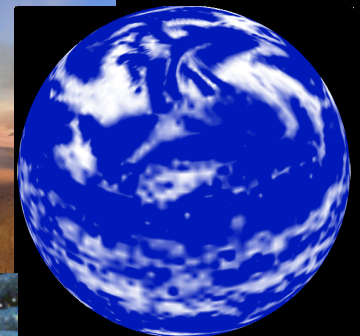
Co-leads:

Natalie Batalha  
Dawn Gelino  
Tony Del Genio

N. Turner  
H. Jang-Condell  
D. Apai

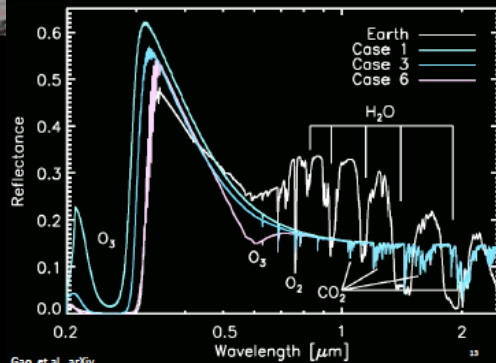
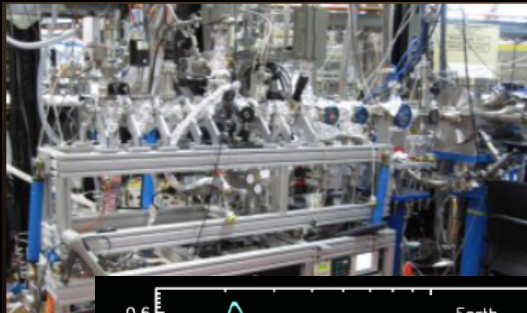
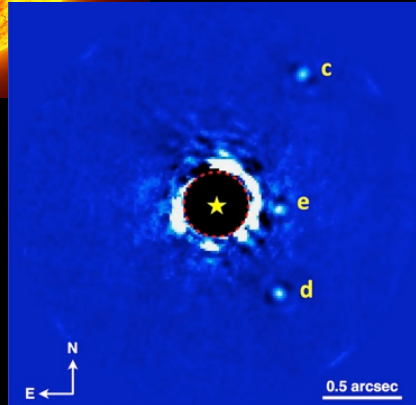
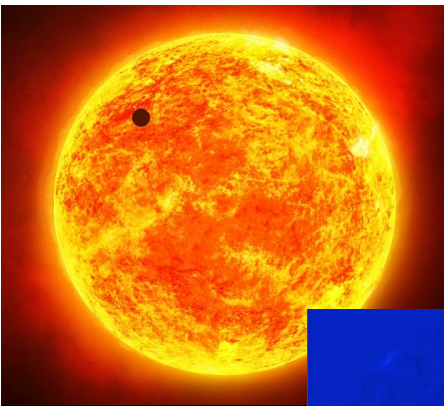


H. Imanaka  
J. Fortney



W. Henning  
S. Desch  
V. Meadows  
T. Del Genio

B. Moore  
V. Airapetian  
D. Brain







Detection of Magnetospheres  
Stellar winds

Astrophysics

Exoplanet Detection  
Star Characterization Existing  
Mission Data Analysis  
Exoplanet Characterization  
Protoplanetary Disks  
Planet Formation

Heliophysics

Earth & Planetary

Goddard  
Airapetian



Jang-Condell



Fischer



PennState

Wright



PennState

Ford



Graham



Turner



Meadows



Henning

Fortney



Deming



Jensen



Desch



Apa



Del Genio



Moore



Brain



Imanaka

HQ Representatives



Voytek  
Still  
Newmark  
Domagal-Goldman

Co-Leads



Del Genio



Ames Research Center

Batalha



Gelino

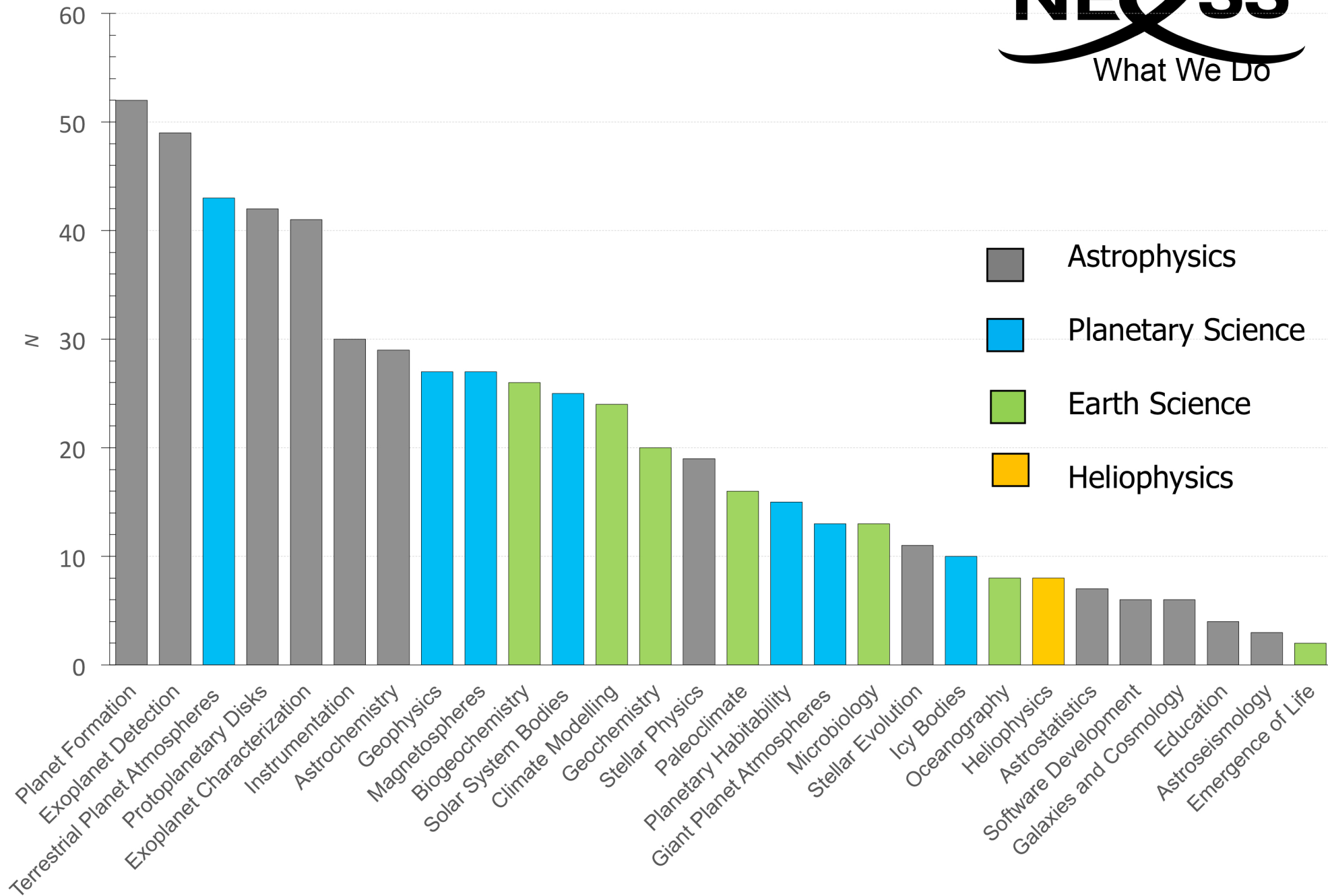
NExSS NPMP

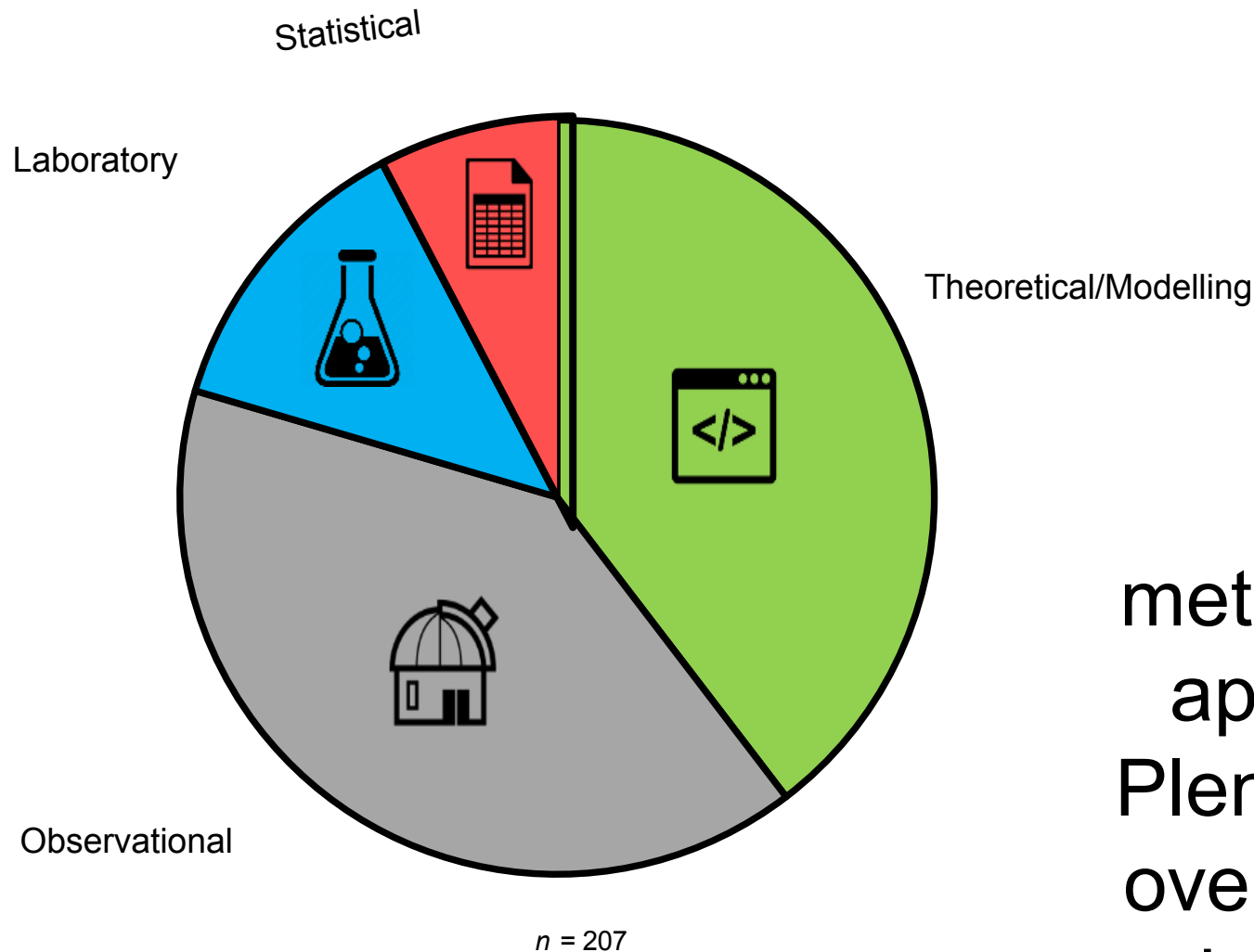


Ames Research Center

Rushby

Comparative Planetology  
Terrestrial Planet Atmospheres  
Biosignatures  
Habitability





Diverse  
methodological  
approaches.  
Plenty of cross-  
over, inter- and  
intra-team.



# Getting Started

Kickoff Meeting April , 2015

Charge to the Teams from Jim Green and  
Paul Hertz

Facilitated working groups

Monthly webinars since June 2015

Getting to know you and your science

Monthly PI telecons

Brainstorming on workshop, communication and  
education activities in support of the NExSS  
goals



## NExSS white paper: Laboratory Work for Understanding Exoplanet Atmospheres (led by J. Fortney, >30)

- Needs for future measurements
  - Pressure-induced line broadening parameters (self- , foreign) - Optical properties of particles, haze formation - Reaction rate constants
  - Photoabsorption cross-sections at high T
  - Lab spectroscopy of continuum absorption
  - Oxygen absorption by early magma ocean
- Draft released for community comment
- Relevant to APDA ROSES NRA highlighting timeliness of Laboratory Astrophysics research in support of JWST

## Workshops:

Upstairs Downstairs: Consequences of Internal Planet Evolution for the Habitability and Detectability of Life on Extrasolar Planets

- Tempe, AZ, Feb. 17-19 (led by PSD)
- Joint NExSS-NAI-NSF effort, in-person + virtual participation (Workshop Without Walls) + winter school for students/postdocs

Biosignatures workshop (led by PSD, APD), July 2016

- Joint NExSS-NAI-ExEP effort
- Partnering with tentatively approved ExoPAG SAG-16 in support of JWST, WFIRST, HabEx/LUVOIR studies

Exoplanetary Space Weather, Climate and Habitability Workshop

-Dec 2016

Identifying which stars are the best place to search for habitable planets and life



# NExSS Face to Face (May 2016) and Exoplanet Talk Show on NASA TV



## Other activities, collaborations:

- Other workshop ideas (priorities identified by poll of teams)
  - How to identify potentially habitable planets (ESD, PSD)
  - Space weather constraints on habitability (HPD, APD)
  - Stellar, disk histories favoring habitability (APD, PSD)
- Cross-team, cross-discipline collaborations occurring in NExSS
  - Planetary scientists and astrophysicists to characterize short-period rocky planets
  - Statistical and machine learning approaches to detect low-mass planets in presence of stellar activity
  - Heliophysicists and astrophysicists to estimate mass loss in young Sun-like stars



# MANY WORLDS

Posted on 2016-04-25 by Marc Kaufman

[Leave a comment](#)

## Breaking Down Exoplanet Stovepipes



*The search for life beyond our solar system requires unprecedented cooperation across scientific disciplines. NASA's NExSS collaboration includes those who study Earth as a life-bearing planet (lower right), those researching the diversity of solar system planets (left), and those on the new frontier, discovering worlds orbiting other stars in the galaxy (upper right). (NASA)*

## About Many Worlds

There are many worlds out there waiting to fire your imagination.

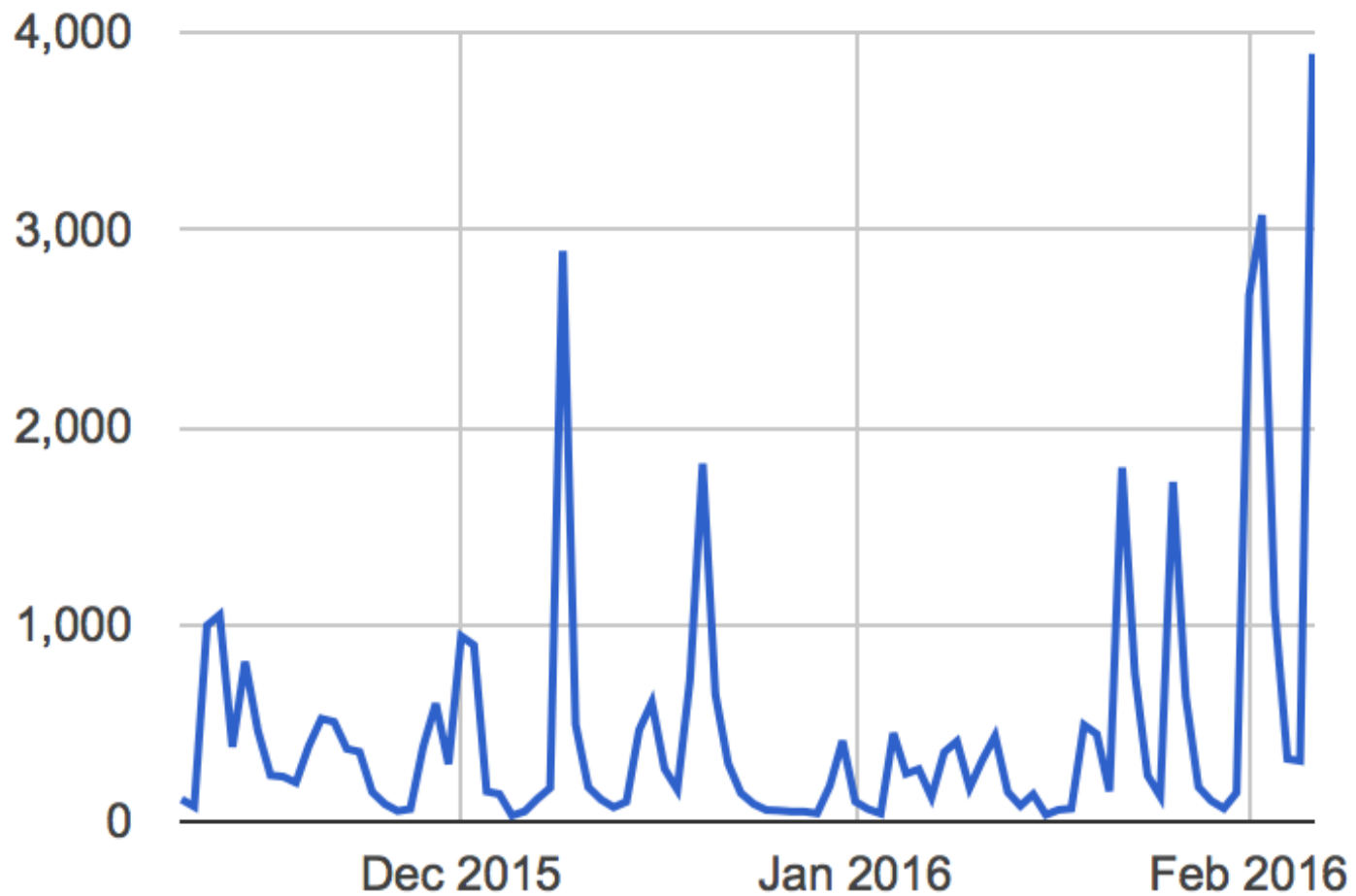
Marc Kaufman is an experienced journalist, having spent three decades at The Washington Post and The Philadelphia Inquirer, and is the author of two books on searching for life and planetary habitability. While the "Many Worlds" column is supported by the Lunar Planetary Institute/USRA and informed by NASA's NExSS initiative, any opinions expressed are the author's alone.

This site is for everyone interested in the burgeoning field of exoplanet detection and research, from the general public to scientists in the field. It will present columns, news stories and in-depth features, as well as the work of guest writers. Many Worlds will be updated at least once a week.

To contact Marc, send an email to [marc.kaufman@manyworlds.space](mailto:marc.kaufman@manyworlds.space).



# Many Worlds Blog Traffic



A decorative header in the top-left corner featuring a collage of celestial bodies: Saturn, Jupiter, Mars, the Moon, and Venus, set against a background of a bright star and a blue nebula. The rest of the header background is a dark blue gradient with white stars.

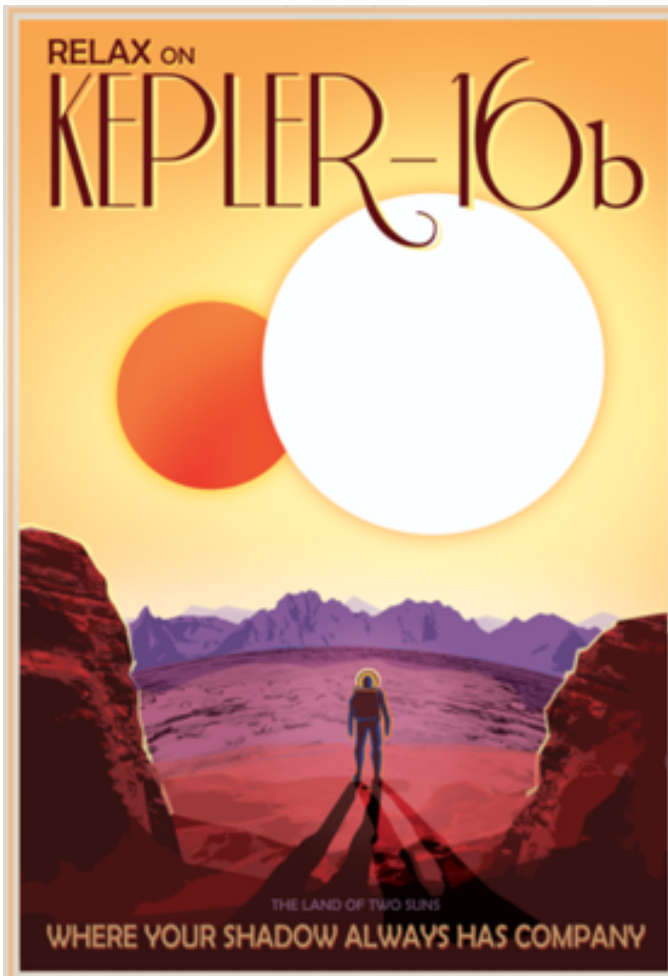
## E.4 HABITABLE WORLDS

NASA's Habitable Worlds Program includes elements of the Astrobiology Program, the Mars Exploration Program, the Outer Planets Program (all in the Planetary Science Division) and Exoplanet research in the Astrophysics Division. A common goal of these programs is to identify the characteristics and the distribution of potentially habitable environments in the Solar System and beyond.

11/18/2016  
(Step-1)

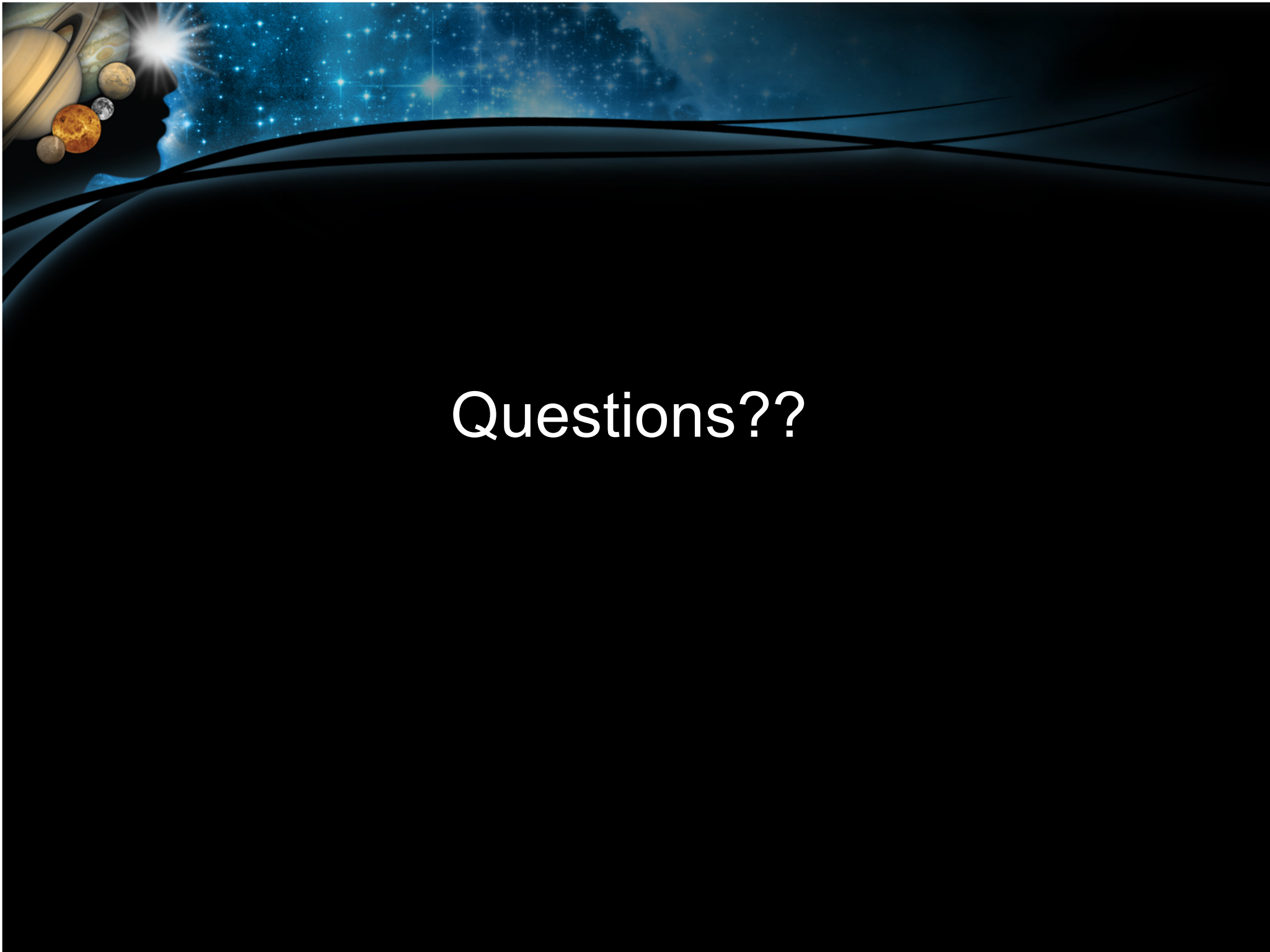
01/20/2017  
(Step-2)





Questions??





Questions??



